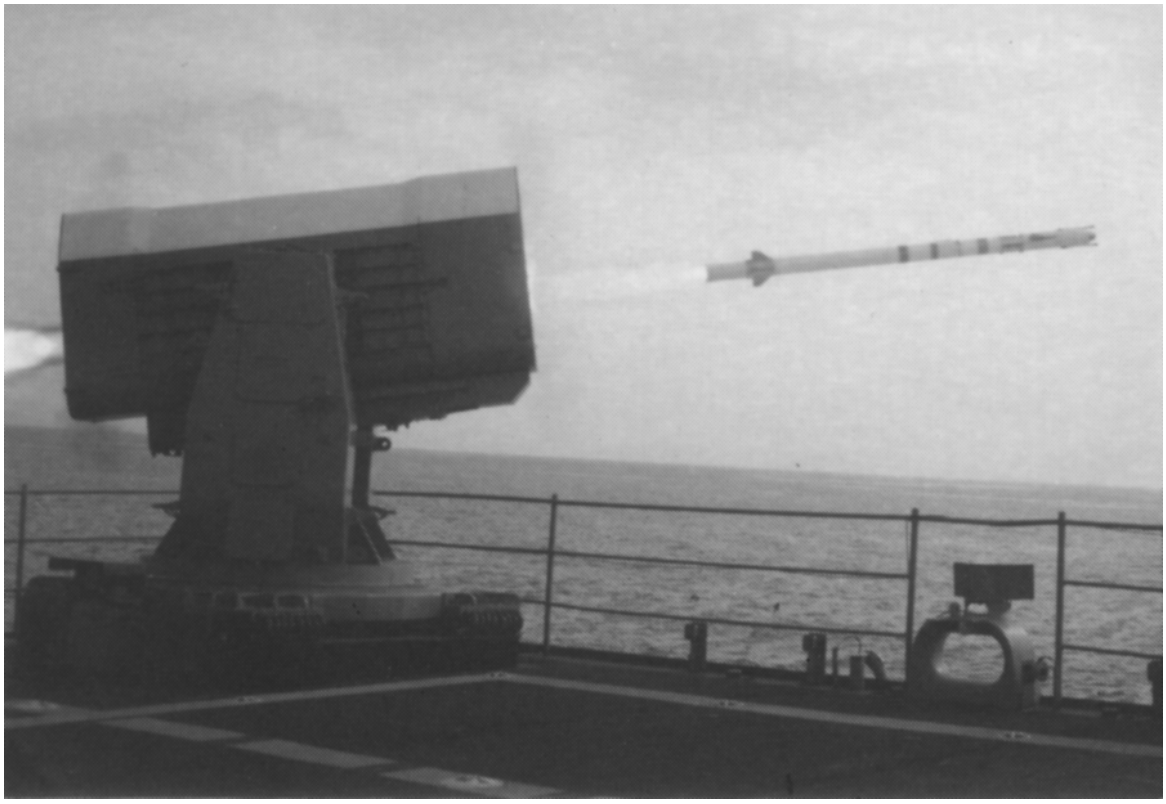
# ROLLING AIRFRAME MISSILE (RAM) WEAPON SYSTEM



**Navy ACAT II Program**

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|---|---|
| Total Number of Systems: | |
| Block 0 missiles: | 1,315 |
| Block I missiles: | 170 |
| Block I retrofit kits: | 325 |
| Launchers: | 156 |
| Total Program Cost (TY$): | $1,709.4M |
| Average Unit Cost (TY$): | $0.273M |
| | $0.444M |
| Full-rate production: | Block 0: FY94 |
| | Block 1: FY00 |

**Prime Contractor**

Raytheon Systems Company
Tucson, AZ

## SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

The Rolling Airframe Missile (RAM) program is designed to provide surface ships with an effective, low-cost, lightweight, self-defense system that will provide an improved capability to engage and defeat incoming anti-ship cruise missiles (ASCMs). The RAM Block 0 has a five-inch diameter airframe that rolls in flight and dual mode, passive radio frequency/infrared (RF/IR) guidance. Initial homing for RAM Block 0 is in RF, using an ASCM's RF seeker emissions. If the ASCM's IR radiation is acquired, RAM transitions to IR guidance. RAM Block I uses an improved, electro-optical proximity fuze and a new IR seeker and can be launched in an IR all-the-way mode, as well as the dual mode

(passive RF, followed by passive IR) used by Block 0. The launching system and missiles comprise the weapon system.

RAM weapon systems are integrated with the AN/SWY-2 or -3 combat system on certain ships and with the Ship Self Defense System (SSDS) Mark 1 on other ships (LSD-41 class ships at this time). The AN/SWY-2 is comprised of the weapon system and the combat direction system. The combat direction system employs the existing Mk 23 target acquisition system (TAS) radar and the AN/SLQ-32(V) electronic warfare support sensor (together with threat evaluation and weapons assignment software resident in the Mk 23 TAS) to accomplish threat detection, correlation, evaluation, and engagement. Within the AN/SWY-3 combat system, RAM provides a short-range air defense capability, with the NATO Sea Sparrow system providing longer range protection. With SSDS, RAM is part of the engagement suite. For example, on LSD 41-class ships, a typical SSDS engagement suite includes RAM, the PHALANX Close-In Weapon System Block 1A, and the decoy launch system. SSDS further integrates the AN/SPS-49A(V)1 radar with the medium pulse repetition frequency upgrade, the AN/SPS-67 surface search radar, the AN/SLQ-32(V) sensor, and the Close In Weapon System (CIWS) search radar. The RAM weapon system will be upgraded with a RAM Helicopter-Aircraft-Surface (HAS) target mode.

RAM Block 0 contributes to the ***Joint Vision 2010*** concept of ***full-dimensional protection*** by enhancing ship self protection against several RF-radiating ASCMs that have "leaked" past outer air defenses. RAM Block I extends that protection against several non-RF radiating missiles. Given that some of the ships using RAM are also platforms from which strike operations are executed, RAM indirectly contributes to the concept of ***precision engagement***.

## BACKGROUND INFORMATION

The Navy established an operational requirement for the RAM weapon system in 1975. The Federal Republic of Germany independently developed a requirement similar to that of the United States, and the two nations signed a memorandum of understanding for joint participation in the advanced development phase of the program. IOT&E was completed in FY90. The DOT&E assessment was reported in DOT&E's FY90 Annual Report. As noted in that report, a B-LRIP report had been prepared for RAM but a final decision to proceed beyond LRIP had not been made. Due to this deferred decision, the B-LRIP report was not forwarded to the congressional defense committees until April 1994, prior to Block 0 missile and launcher full rate production. The B-LRIP report concluded that the RAM weapon system was operationally effective against the preponderance of RF-emitting ASCMs, although there were exceptions. It also concluded that RAM Block 0 was not operationally suitable. These deficiencies were addressed prior to the decision to proceed beyond LRIP, with the new Block I missile program addressing the more fundamental deficiencies. The RAM Block I program is currently in engineering and manufacturing development and addresses the deficiencies and weaknesses reported in the BLRIP report on the Block 0 system. An OA, based on DT at the White Sands Missile Range, NM, was conducted in FY97. Notwithstanding the limitations associated with testing a missile—intended to operate in a maritime environment—in the high desert, based on results of the DT and M&S, RAM Block I was projected to be potentially operationally effective. Limitations precluded projection of potential operational suitability.

RAM Block 1 was designated for LFT&E oversight in a memorandum from the Deputy Director Test and Evaluation/Land and Maritime Programs (currently the Deputy Director Operational Test and Evaluation/Live Fire Test and Evaluation) to the Navy on January 31, 1994. The objective of the

LFT&E is to evaluate the lethality of the warhead against RAM Block 0 targets to assure no degradation of lethality, and against the updated RAM Block 1 target set. Data for the evaluation will be derived from warhead arena testing, OPEVAL results, and from modeling and simulation. Other sources of data on the lethality of the WDU-17/B warhead, such as those derived from the Live Fire Test and Evaluation of the AIM-9X missile, (which carries the same warhead) will also be employed.

## TEST & EVALUATION ACTIVITY

Developmental and operational testing were conducted from August 1998 through August 1999. This included firing Block 1 missiles during simulated attacks by ASCMs and threat-representative surrogates against the unmanned, remotely controlled Self Defense Test Ship (SDTS). The SDTS is used in order to conduct operationally realistic testing without endangering lives and without risking a fleet ship. Testing was conducted concurrently with FOT&E of the Ship Self Defense System (SSDS) Mark 1 and OPEVAL of the Phalanx Close-In Weapon System Block 1B. SSDS was the integrating element for both the engagement suite, consisting of the RAM weapon system and the CIWS, and the sensor suite, consisting of the AN/SPS-49A(V) radar, the CIWS search and tracking radars, and the AN/SLQ-32(V)3 electronic warfare sensor. This combat system configuration was close to that of an LSD 41 class ship, except that the CIWS Block 1A (without electro-optical tracking capability) is part of the LSD configuration vice the Block 1B and the LSD suite includes an AN/SPS-67 surface search radar but SDTS did not. This testing was conducted at the Naval Air Warfare Center, Weapons Division outer sea range near Point Mugu, CA. A separate phase of OPEVAL was conducted onboard USS GUNSTON HALL (LSD 44) to address operational suitability issues associated with the RAM Block 1 upgrade. The OPEVAL was conducted in accordance with a DOT&E-approved test plan and TEMP. Members and representatives of the Director's staff observed the testing.

Testing was delayed, first by a leak in the 43 year-old hull of the SDTS and, later as a result of a target hitting the SDTS during an SSDS FOT&E scenario (during which Block 0 - not Block 1 - missiles were used, along with CIWS).

Planning was initiated for T&E of the RAM Helicopter-Aircraft-Surface (HAS) target mode.

## TEST & EVALUATION ASSESSMENT

**RAM Block 0.** Our current assessment of RAM Block 0 remains that it is operationally effective against most of the RF-emitting ASCMs and that it is operationally suitable. Performance against targets executing evasive maneuvers has not been tested because these targets were not available, nor was the SDTS available for OT of RAM Block 0 against the most realistic threat attack profiles. Block 0 rounds are being configured with the new electro-optical fuze that is used in RAM Block 1.

**RAM Block 1.** The testing was adequate to determine that RAM Block 1 is operationally effective against most current ASCMs, as supported by the SSDS Mark 1, integrating an AN/SPS-49A(V) search radar, a CIWS Block 1B, and an AN/SLQ-32(V)3 electronic warfare system. The CIWS radar was essential in tracking targets and supporting RAM Block 1 launches. By no means can the operational effectiveness assessment of RAM Block 1 be divorced from the combat systems suite used in testing. RAM Block 1 is operationally suitable. Assessment of RAM Block 1 when supported by other combat systems (especially any without CIWS) will require independent OT with that particular combat system on a SDTS. RAM Block 1 capability was examined against representative targets from all ASCM

threat categories but one. That category is currently populated by a single projected threat. A surrogate target is being developed for FOT&E to investigate RAM Block 1 capability in this category.

From OPEVAL results, under the conditions tested, the RAM Block 1 is lethal against most current ASCMs. Warhead arena testing conducted in 1994, previous tests with this warhead, and AIM-9X LFT&E testing being conducted in late FY99, provide material for estimating the warhead's damage capabilities and lethal radius against a variety of targets and structures.

The B-LRIP report with the LFT&E report was published and provided to the congressional defense committees, the Secretary of Defense, and the Under Secretary of Defense for Acquisition and Technology. RAM models and supporting models are being validated with FY99 test results. Simulations will be run with these models to examine predicted performance under conditions of parameter excursion, in preparation for FOT&E of Block 1.

## CONCLUSIONS, RECOMMENDATIONS, LESSONS LEARNED

The OPEVAL of RAM Block 1 is considered the most operationally realistic and stressful testing of a Navy air defense missile system—ever. That this was achieved is due both to the Program Manager's cooperation in obtaining threat-representative targets and the availability of the SDTS. This unique test asset allowed thorough examination of RAM Block 1 within its intended operational environment. Significant information regarding capabilities and limitations was learned during this realistic testing that could not have been obtained otherwise, short of use in combat.